Oklahoma Geological Survey
THE UNIVERSITY OF OKLAHOMA
MEWBOURNE COLLEGE OF EARTH & ENERGY
G. Randy Keller, Director and State Geologist

June 14, 2013

Mr. Michael Overbay, P.G.
Regional Groundwater Center
U.S. Environmental Protection Agency
US EPA-6
1445 Ross Ave., Suite 1200
Dallas, Texas 75202-2733

Dear Michael,

The Oklahoma Geological Survey (OGS) is holding a workshop to discuss best practices regarding fluid injection induced seismicity. The proposed best practices have been reviewed by researchers from the academic community, and now the OGS is soliciting response from stakeholders within Oklahoma and other interested stakeholders on these best practices. You can find the best practices we will be discussing at the workshop on July 16th, attached. The workshop will be by invitation only, and will not include any media. We are trying to keep the number of people in attendance to a manageable number, because we would like the breakout sessions in the afternoon to be productive. We request that you limit attendance to no more than two or three people from your organization.

We hope that you will be able to join us on Tuesday July 16th for what is sure to be a productive workshop. Please RSVP with the attached preregistration form or email all of the requested information to mjsummers@ou.edu. Preregistration will help us to have an accurate meal count for lunch (provided).

Sincerely,

Randy Keller

Dr. G. Randy Keller
Director, Oklahoma Geological Survey
University of Oklahoma Mewbourne College of Earth and Energy
100 E. Boyd St., Room N131
Norman, OK 73019

PREREGISTRATION FORM—Please pre-register so we may have an accurate meal count for lunch (provided).

Please fill out form, detach, and return to: **Oklahoma Geological Survey, 100 E. Boyd, Room N-131, Norman, Oklahoma 73019**

NAME: (Last) _____ (First) _____ (Initial) _____

AFFILIATION: _____ (Nickname for badge) _____

MAILING ADDRESS: _____ PHONE: _____

CITY: _____ STATE: _____ ZIP: _____ FAX: _____

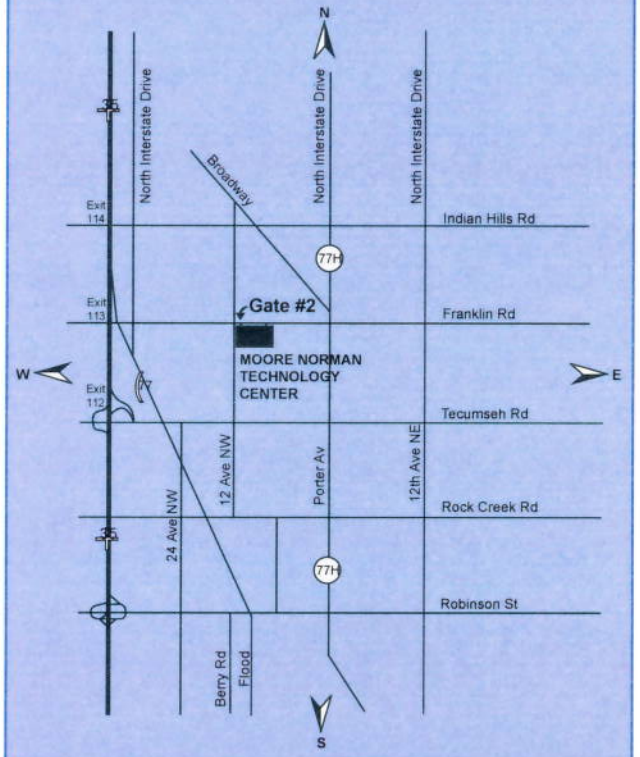
E-MAIL: _____

FURTHER INFORMATION

Technical questions: **Austin Holland, Oklahoma Geological Survey,** 405/325-8497; cell 405/361-9967; austin.holland@ou.edu. Registration and other information: **Michelle Summers** 405/325-7313, mjsummers@ou.edu.

TRANSPORTATION

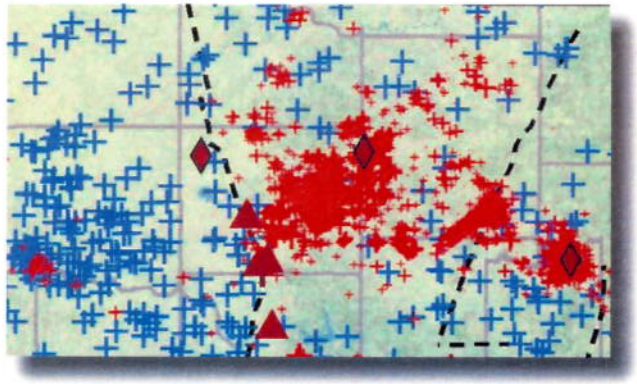
Will Rogers World Airport is 25 minutes from the Moore Norman Technology Center in Norman. Ground transportation (taxis, rental cars, and airport shuttle for hire) is available in the baggage claim area. Parking at the Moore Norman Technology Center is free.



Moore Norman Technology Center
Main Campus - (405) 364-5763
4701 12th Avenue NW, Norman, Oklahoma

Southbound from Oklahoma City take Exit 113 and turn left on Franklin Rd. Turn right at Gate 2 entrance.

Northbound traffic take Exit 112. Turn left (east) on Tecumseh Rd. Turn left (north) on 12th Ave NW. Turn right (east) on Franklin Rd. Turn right at Gate 2 entrance.



Fluid Injection Induced Seismicity Workshop

July 16, 2013

Oklahoma Geological Survey
G. Randy Keller, Director

The University of Oklahoma
MEWBOURNE COLLEGE OF EARTH & ENERGY

Establishing Best Practices for Fluid Injection Induced Seismicity

In response to concerns about the potential for triggered* seismicity in the state, the Oklahoma Geological Survey is developing a set of recommended best practices for the siting and operation of wastewater disposal wells which could be applied to any area with oil and gas operations. The recommendations will be based on current understanding of the possible causes of triggered seismicity, and will be developed in consultation with interested parties – The Oklahoma Corporation Commission, representatives from industry, and representatives from environmental groups. This is the opportunity to get all those who may be affected involved in the discussion of developing best practices for fluid injection.

Program Agenda

9:00	Welcome and Introduction
9:15-10:00	Enhanced Geothermal Best Practices, Lessons Learned
10:00-10:45	Perspective from Industry
11:00-12:00	Proposed Best Practices
12:00-1:00	Lunch (provided)
1:00-2:30	Breakout groups
2:45-3:45	Wrap-up

Considerations in Developing Best Practices

1. Faults: Fluid injection on to or near faults raises pore pressure which, if the fault is close to critical stress, can trigger seismic events. For this reason, injection wells should not be located in proximity to known faults; should the "safe distance" for an injection well from a fault be evaluated from the assessed risk of triggered seismicity, and how is that risk determined?

2. The risk of triggered seismicity is higher on faults that are favorably oriented relative to the ambient stress field. In this situation, should the "safe distance" for an injection well be greater, and how will that "safe distance" be determined in each instance?

3. How frequently should fluid injection pressure and volume be monitored and recorded during the operation of an injection well?

4. Should formation (in-situ) pressure be monitored in real time if possible? If this is not practical, how regularly should shut-in or pressure fall-off tests be conducted to determine formation pressure?

5. Greater stresses accumulate in Precambrian basement than in the sedimentary cover, with the potential that triggered earthquakes in basement will be of larger magnitude. For this reason, should fluid injection directly into Precambrian basement be avoided? Additionally, where sedimentary formations have a hydraulic connection to the basement, is there a minimum depth above basement in which fluid injection should be avoided?

6. In operations that involve both production and injection of fluids in nearby wells, should volumes be balanced to avoid a major change in net fluid volume in the formation(s) of production and injection?

7. In an area of known seismicity or near a large fault, the siting of a new injection well should be approached with more caution. In this circumstance, should more frequent monitoring of injected volume, injection pressure, and formation pressure be recommended, in combination with comprehensive monitoring of seismicity?

8. In cases where fluid injection is occurring in geological environments with a greater assessed risk of triggered seismicity, should additional geotechnical information, such as mini-fracs and image logs (which will provide additional constraints on injection limits), be obtained?

9. If it is assessed that a new injection well will be operating in a geological environment where triggered seismicity is more likely, should the operator have in place a seismic monitoring system capable of detecting relatively small earthquakes (less than magnitude 2.0)? Should the monitoring system be in operation prior to (to establish baseline activity) and during (to monitor any potential triggered seismicity) injection, and remain operational for a period of time after injection has ceased? For transparency, should the seismic data recorded be made publically available?

10. Should it be advisable for *all* new injection wells to have a seismic monitoring system in place prior to and during the first few months of operations and, additionally, whenever injection parameters, such as rate or pressure of injection, change significantly?

11. Should operators have a response plan that addresses actions to be taken (e.g., modifications to injection parameters), in a timely manner, in the event of, for example, changes in formation pressure or the onset of unexpected, potentially triggered, seismicity? Should a "traffic light system" (e.g., ***Earth*** magazine, April 2012) be established and implemented to mitigate potentially triggered seismicity?

* *For simplicity, triggered is used herein to refer to the possibility of both triggered and induced seismic events.*